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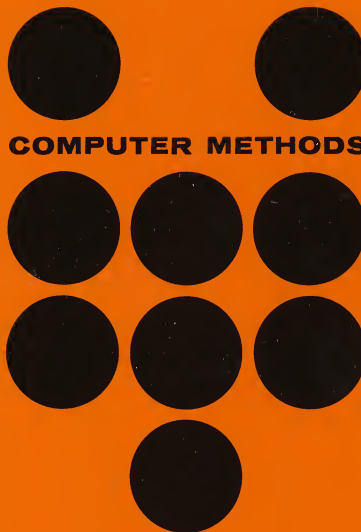
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COMPUTER METHODS CORPORATION

Reference Table for IBM Direct Access Mass Storage Units

Organization and Pricing Summary—IBM Direct Access Devices

Table-A

Unit	Type	Max Storage Capacity (in millions) ¹	Storage Organization ²	Transfer Rate (thousands/sec.)	Number of Access Mechanisms	Access Time (in milliseconds)		Representative Cost per million bytes/chars. (Rental, 1 shift) ^{1,3}
						Rotational Delay Max (Avg)	Head Positioning Min-Max (Avg)	
1301	disk file	56.00 characters	2,800 characters/track 40 tracks/cylinder 250 cylinders/module [2] modules/unit	90.1 chars 6-Bit Mode 70.1 chars 8-Bit Mode	1 per module (40 r-w heads)	34 (17)	50-180 (165)	\$75.00 single module \$62.50 double module
1302	disk file	234.00 characters	5,850 characters/track 40 tracks/cylinder 500 cylinders/module [2] modules/unit	184.0 chars 6-Bit Mode 143.0 chars 8-Bit Mode	2 per module (40 r-w heads each)	34 (17)	50-180 (165)	\$47.86 single module \$33.76 double module
1311	removable disk pack drive	2.00 characters sector mode 2.98 characters track mode	100 characters/sector 20 sectors/track 10 tracks/cylinder 100 cylinders/pack	50.0 characters	1 per drive (10 r-w heads)	42 (22)	54-250 w/dir acc. feature (150) 75-392 w/o dir acc. feature (250)	(varies with model) typical drive: \$180.00 sector mode \$121.00 track mode
2301	4 bit parallel drum	4.09 bytes	20,486 bytes per addressable track group 200 addressable track groups per drum	1,200.0 bytes	1 (800 r-w heads)	17.5 (8.6)	(negligible)	\$550.12
2302	disk file	224.28 bytes	4,984 bytes/track 45 tracks/cylinder 500 cylinders/module [2] modules/unit	156.0 bytes	2 per module (45 r-w heads each)	34 (17)	50-180 (165)	\$49.94 single module \$35.22 double module \$51.41* \$36.27*
2303	bit serial drum	3.91 bytes	4,882 bytes/track 800 tracks/drum	312.5 bytes	1 (800 r-w heads)	17.5 (8.6)	(negligible)	\$639.30 \$658.57*
2311	removable disk pack drive	7.25 bytes	3,625 bytes/track 10 tracks/cylinder 200 cylinders/pack	156.0 bytes	1 per drive (10 r-w heads)	25 (12.5)	30-145 (85)	\$79.31 \$81.38*
2314	removable disk pack file	207.00 bytes	7,188 bytes/track 18 tracks/cylinder 200 cylinders/module 8 modules/file (9th module provided as spare)	312.0 bytes	1 per module (18 r-w heads)	25 (12.5)	20-140 (75)	\$25.36 \$26.13*
2321	removable data cell drive	400.00 bytes	2,000 bytes/track 20 tracks/cylinder 5 cylinders/strip [20] strips/bin [10] bins/cell [10] cells/drive	55.0 bytes	1 per frame (20 r-w heads)	50 (25)	95-400 w/o restore 375-600 with restore	\$7.00 \$7.21*

¹Listed capacity and representative cost are for maximum unit configuration shown.

²Variables in configuration are enclosed in brackets.

³Representative cost does not include any associated control units, etc.

⁴Price increase effective 1/1/67

Maximum Record Sizes (characters or bytes per track) and Transmission Times (milliseconds per record) for IBM Direct Access Devices

Records per Track	1301				1302				1311		2301				2302				Records per Track
	Chars/Record 6-Bit Mode	Trans Time in ms	Chars/Record 8-Bit Mode	Trans Time in ms	Chars/Record 6-Bit Mode	Trans Time in ms	Chars/Record 8-Bit Mode	Trans Time in ms	Chars/Record	Trans Time in ms	With Keys Bytes/Record	Trans Time in ms	Without Keys Bytes/Record	Trans Time in ms	With Keys Bytes/Record	Trans Time in ms	Without Keys Bytes/Record	Trans Time in ms	
1	2800	31.07	2165	30.88	5850	31.79	4533	31.70	2000	40.00	20430	17.02	20483	17.07	4964	31.82	4984	31.95	1
2	1381	15.32	1063	15.16	2900	15.76	2241	15.67	1000	20.00	10122	8.43	10175	8.48	2383	15.28	2402	15.40	2
3	908	10.08	696	9.93	1916	10.41	1477	10.33	666	13.32	6686	5.57	6739	5.62	1550	9.94	1569	10.06	3
4	671	7.45	512	7.30	1425	7.74	1095	7.66	500	10.00	4968	4.14	5021	4.18	1138	7.29	1157	7.42	4
5	529	5.87	402	5.73	1130	6.14	866	6.06	400	8.00	3937	3.28	3990	3.32	892	5.72	912	5.85	5
6	435	4.83	329	4.69	933	5.07	713	4.99	333	6.66	3250	2.71	3303	2.75	729	4.67	749	4.80	6
7	367	4.07	276	3.94	792	4.30	604	4.22	285	5.70	2759	2.30	2812	2.34	613	3.93	632	4.05	7
8	316	3.51	237	3.38	687	3.73	522	3.65	250	5.00	2391	1.99	2444	2.04	526	3.37	546	3.50	8
9	277	3.07	206	2.94	605	3.29	459	3.21	222	4.44	2104	1.75	2157	1.80	459	2.94	478	3.06	9
10	245	2.72	182	2.60	540	2.94	408	2.85	200	4.00	1875	1.56	1928	1.61	405	2.60	424	2.72	10
11	220	2.44	162	2.31	486	2.64	366	2.56	181	3.62	1688	1.41	1741	1.45	361	2.31	380	2.44	11
12	198	2.20	145	2.07	441	2.40	331	2.32	166	3.24	1532	1.28	1585	1.32	324	2.08	343	2.20	12
13	180	2.00	131	1.87	403	2.19	302	2.11	153	3.06	1399	1.17	1452	1.21	293	1.88	312	2.00	13
14	164	1.82	119	1.70	371	2.02	277	1.94	142	2.84	1286	1.07	1339	1.12	266	1.71	285	1.83	14
15	151	1.68	108	1.54	343	1.86	255	1.78	133	2.66	1188	.99	1241	1.03	244	1.56	263	1.69	15
16	139	1.54	99	1.41	318	1.73	236	1.65	125	2.50	1102	.92	1155	.96	224	1.44	243	1.56	16
17	128	1.42	91	1.30	297	1.61	219	1.53	117	2.34	1026	.85	1079	.90	205	1.31	224	1.44	17
18	119	1.32	84	1.20	277	1.51	204	1.43	111	2.22	959	.80	1012	.84	189	1.21	208	1.33	18
19	111	1.23	77	1.10	260	1.41	191	1.34	105	2.10	899	.75	952	.79	176	1.13	195	1.25	19
20	103	1.14	72	1.03	245	1.33	179	1.25	100	2.00	844	.70	897	.75	163	1.04	182	1.17	20
21	97	1.08	66	.94	230	1.25	168	1.18	95	1.90	795	.66	848	.71	151	.97	170	1.09	21
22	91	1.01	62	.88	218	1.19	158	1.11	90	1.80	751	.63	804	.67	141	.90	160	1.03	22
23	85	.94	57	.81	206	1.12	149	1.04	86	1.72	710	.59	763	.64	131	.84	150	.96	23
24	80	.89	53	.76	195	1.06	140	.98	83	1.66	673	.56	726	.60	122	.78	142	.91	24
25	75	.83	50	.71	186	1.01	133	.93	80	1.60	638	.53	691	.58	115	.74	134	.86	25
26	71	.79	46	.66	176	.96	126	.88	76	1.52	606	.50	649	.55	107	.69	126	.81	26
27	67	.74	43	.61	168	.91	119	.83	74	1.48	577	.48	630	.52	101	.65	120	.77	27
28	63	.70	40	.57	160	.87	113	.79	71	1.42	550	.46	603	.50	94	.60	113	.72	28
29	59	.66	37	.53	153	.83	108	.75	68	1.36	524	.44	577	.48	88	.56	107	.69	29
30	56	.62	35	.50	146	.79	102	.71	66	1.32	501	.42	554	.46	82	.53	102	.65	30
31	53	.59	33	.47	140	.76	97	.68	64	1.28	479	.40	532	.44	77	.49	96	.62	31
32	50	.56	30	.43	134	.73	93	.65	62	1.24	458	.38	511	.43	72	.46	91	.58	32
33	48	.53	28	.40	129	.70	88	.62	60	1.20	438	.36	491	.41	68	.44	87	.56	33
34	45	.50	26	.37	124	.67	84	.59	58	1.16	420	.35	473	.39	63	.40	82	.53	34
35	43	.48	24	.34	118	.64	80	.56	57	1.14	403	.34	456	.38	60	.38	79	.51	35
36	40	.44	23	.33	113	.61	77	.54	55	1.10	386	.32	439	.37	56	.36	75	.48	36
37	38	.42	21	.30	109	.59	73	.51	54	1.08	371	.31	424	.35	52	.33	71	.46	37
38	36	.40	19	.27	105	.57	70	.49	52	1.04	356	.30	409	.34	48	.31	67	.43	38
39	34	.38	18	.26	101	.55	67	.47	51	1.02	342	.28	385	.33	45	.29	64	.41	39
40	32	.36	17	.24	97	.53	64	.45	50	1.00	329	.27	382	.32	42	.27	61	.39	40
41	31	.34	15	.21	93	.51	61	.43	48	.96	316	.26	369	.31	40	.26	59	.38	41
42	29	.32	14	.20	90	.49	59	.41	47	.94	304	.25	357	.30	37	.24	56	.36	42
43	28	.31	13	.19	87	.47	56	.39	46	.92	293	.24	346	.29	34	.22	53	.34	43
44	26	.29	12	.17	84	.46	54	.38	45	.90	282	.23	335	.28	31	.20	50	.32	44
45	25	.28	10	.14	81	.44	51	.36	44	.88	272	.23	325	.27	29	.19	48	.31	45
46	23	.26	9	.13	78	.42	49	.34	43	.86	262	.22	315	.26	26	.17	45	.29	46
47	22	.24	8	.11	76	.41	47	.33	42	.84	252	.21	305	.25	24	.15	43	.28	47
48	21	.23	7	.10	72	.39	45	.32	41	.82	243	.20	296	.25	22	.14	41	.26	48
49	19	.21	6	.09	70	.38	43	.30	40	.80	234	.19	287	.24	20	.13	40	.26	49
50	18	.20	6	.09	68	.37	41	.29	40	.80	226	.19	279	.23	18	.12	34	.24	50
51	17	.19	5	.07	65	.35	39	.27	39	.78	218	.18	271	.23	16	.10	35	.22	51
52	16	.18			63	.34	38	.27	38	.76	210	.17	263	.22	15	.10	34	.22	52
53	15	.17			61	.33	36	.25	37	.74	202	.17	255	.21	13	.08	32	.21	53
54	14	.16			59	.32	34	.24	37	.74	195	.16	248	.21	11	.07	30	.19	54
55	13	.14			57	.31	33	.23	36	.72	188	.16	241	.20	9	.06	28	.18	55
56	12	.13			56	.30	31	.22	35	.70	182	.15	235	.20	8	.05	27	.17	56
57	11	.12			53	.29	30	.21	35	.70	172	.15	228	.19	6	.04	25	.16	57
58	10	.11			51	.28	29	.20	34	.68	169	.14	222	.18	5	.03	24	.15	58
59	10	.11			50	.27	27	.19	33	.66	163	.14	216	.18			22	.14	59
60	9	.10			48	.26	26	.18	33	.66	157	.13	210	.17			21	.13	60

Table-B

	Records per Track	2303				2311				2314				2321				Records per Track
		With Keys		Without Keys		With Keys		Without Keys		With Keys		Without Keys		With Keys		Without Keys		
		Bytes/ Record	Trans Time in ms	Bytes/ Record	Trans Time in ms	Bytes/ Record	Trans Time in ms	Bytes/ Record	Trans Time in ms	Bytes/ Record	Trans Time in ms	Bytes/ Record	Trans Time in ms	Bytes/ Record	Trans Time in ms	Bytes/ Record	Trans Time in ms	
05	1	4854	15.53	4892	15.65	3605	23.11	3625	23.24	7163	22.96	7167	22.97	1984	36.07	2000	36.36	1
10	2	2354	7.53	2392	7.65	1719	11.02	1739	11.15	3569	11.44	3573	11.45	919	16.71	935	17.00	2
16	3	1520	4.86	1558	4.99	1111	7.12	1130	7.24	2371	7.60	2375	7.61	575	10.45	591	10.75	3
25	4	1104	3.53	1142	3.65	810	5.19	829	5.31	1772	5.68	1776	5.69	406	7.38	421	7.65	4
32	5	854	2.73	892	2.85	631	4.04	650	4.17	1412	4.53	1416	4.54	304	5.53	320	5.82	5
30	6	687	2.20	725	2.32	511	3.28	530	3.40	1173	3.76	1177	3.77	237	4.31	252	4.58	6
05	7	568	1.82	606	1.94	427	2.74	446	2.86	1001	3.21	1005	3.22	189	3.44	204	3.71	7
50	8	479	1.53	517	1.65	364	2.33	383	2.46	873	2.80	877	2.81	153	2.78	168	3.05	8
06	9	409	1.31	447	1.43	314	2.01	333	2.13	773	2.48	777	2.49	125	2.27	141	2.56	9
72	10	354	1.13	392	1.25	275	1.76	294	1.88	693	2.22	697	2.23	103	1.87	119	2.16	10
44	11	308	.99	346	1.11	243	1.56	262	1.68	628	2.01	632	2.03	84	1.53	100	1.82	11
20	12	270	.86	308	.99	216	1.38	235	1.51	574	1.84	578	1.85	70	1.27	85	1.55	12
00	13	238	.76	276	.88	193	1.24	212	1.36	527	1.69	531	1.70	57	1.04	72	1.31	13
33	14	211	.68	249	.80	173	1.11	193	1.24	488	1.56	492	1.58	46	.84	61	1.11	14
59	15	187	.60	225	.72	157	1.01	176	1.13	454	1.46	458	1.47	37	.67	52	.95	15
66	16	166	.53	204	.65	142	.91	161	1.03	424	1.36	428	1.37	28	.51	43	.78	16
44	17	148	.47	186	.60	129	.83	148	.95	397	1.27	401	1.29	20	.36	36	.65	17
33	18	131	.42	169	.54	118	.76	137	.88	374	1.20	378	1.21	14	.25	29	.53	18
25	19	117	.37	155	.50	107	.69	126	.81	353	1.13	357	1.14	8	.15	23	.42	19
17	20	104	.33	142	.45	98	.63	117	.75	334	1.07	338	1.08			19	.35	20
09	21	92	.29	130	.42	89	.57	108	.69	317	1.01	321	1.03			14	.25	21
03	22	81	.26	119	.38	81	.52	101	.65	301	.96	305	.98			9	.16	22
06	23	71	.23	109	.35	75	.48	94	.60	287	.92	291	.93			5	.09	23
01	24	62	.20	100	.32	68	.44	87	.56	274	.88	278	.89					24
36	25	54	.17	92	.29	62	.40	81	.52	262	.84	266	.85					25
31	26	46	.15	84	.27	57	.37	76	.49	251	.80	255	.82					26
77	27	39	.12	77	.25	52	.33	71	.46	241	.77	245	.79					27
72	28	32	.10	70	.22	47	.30	66	.42	231	.74	235	.75					28
39	29	26	.08	64	.20	43	.28	62	.40	222	.71	226	.72					29
55	30	20	.06	58	.19	39	.25	58	.37	214	.69	218	.70					30
32	31	15	.05	53	.17	35	.22	55	.35	206	.66	210	.67					31
58	32	10	.03	48	.15	32	.21	51	.33	199	.64	203	.65					32
56	33	5	.02	43	.14	28	.18	47	.30	192	.62	196	.63					33
53	34			39	.12	25	.16	44	.28	186	.60	190	.61					34
51	35			34	.11	22	.14	41	.26	180	.58	184	.59					35
48	36			30	.10	20	.13	39	.25	174	.56	178	.57					36
46	37			27	.09	17	.11	36	.23	169	.54	173	.55					37
43	38			23	.07	15	.10	34	.22	164	.53	168	.54					38
41	39			20	.06	12	.08	31	.20	159	.51	163	.52					39
39	40			17	.05	10	.06	29	.19	154	.49	158	.51					40
38	41			13	.04	7	.04	26	.17	150	.48	154	.49					41
36	42			11	.04	5	.03	24	.15	146	.47	150	.48					42
34	43			8	.03			22	.14	142	.46	146	.47					43
32	44			5	.02			20	.13	138	.44	142	.46					44
31	45							19	.12	134	.43	138	.44					45
29	46							18	.12	131	.42	135	.43					46
28	47							16	.10	127	.41	131	.42					47
26	48							14	.09	124	.40	128	.41					48
26	49							13	.08	121	.39	125	.40					49
24	50							11	.07	118	.38	122	.39					50
22	51							10	.06	115	.37	119	.38					51
22	52							8	.05	113	.36	117	.37					52
21	53							7	.04	110	.35	114	.37					53
19	54							6	.04	108	.35	112	.36					54
18	55							5	.03	105	.34	109	.35					55
17	56									103	.33	107	.34					56
16	57									101	.32	105	.34					57
15	58									98	.31	102	.33					58
14	59									96	.31	100	.32					59
13	60									94	.30	98	.31					60

The enclosed Reference Table for IBM Direct Access Devices is the second in a series of EDP Tables to be released by Computer Methods Corporation. As with our Tape Reference Table, this chart was developed for use within the company, and proved to be such a valuable tool for our programmers and analysts that CMC is making it available to the entire data processing community.

The Table is divided into two distinct sections—Table A which is an organization and pricing summary for all IBM direct access devices and Table B which lists the maximum record sizes and record transmission times for these devices.

Besides enabling you to become a cocktail party expert on the relative costs and organization of the various IBM devices, Table A illustrates the trade-off between access times and cost. It is a handy reference for determining the storage capacities, organization, transfer rates and access times for these devices.

Table B is particularly effective in determining storage requirements and timing considerations in the systems analysis and design phases of a project. It will enable the analyst

to determine the effect of record length on the number of records that can be stored on a "track"—which we have selected as the basic unit of storage for all direct access devices. It will also enable the analyst to determine read/write times for his data records and thus compute job time and throughput in a direct access limited system.

Note that Table B lists the maximum record size in characters or bytes for a specific number of records per track. To use Table B, the reader need only search the record length column entries (RL_t) for the appropriate device with his record length (RL_i) and satisfy the conditions: $RL_i = RL_t$ or $RL_{t-1} < RL_i < RL_t$.

That is, he need only find a table length entry equal to his record length entry or fit his entry between two consecutive table entries. Having done this, he would read the corresponding entry for RL_t in the "Records per Track" column to find the maximum number of such sized records that could be stored per track.

When considering a device for which Table B gives a columnar breakdown for records "with keys" and "without keys" (2300 series),

the reader need not concern himself with key length as a separate factor. The maximum size indicated for records with keys is the sum *total* of the record data length (DL) *plus* the key length (KL). For example, if the reader desired to know the maximum number of records per track he could obtain on the 2302 disk file for a record with a data length (DL) of 100 bytes and a key length (KL) of 10 bytes, he need only sum the two ($DL + KL = 110$ bytes) and search the "with key" column for a fit. Since 110 falls between the entries 107 and 115 ($107 < 110 < 115$), he would read "25" from the "records per track" column for the entry 115.

Note also that both Tables A and B must be used in determining the total time involved in a direct access operation for a specific device. Total time in an operation is equal to the sum of "rotational delay" time *plus* "head positioning" time *plus* "record transmission time." All of these times are expressed in milliseconds on the tables so no conversion is necessary. Refer to Table A to obtain rotational delay and head positioning times and refer to Table B for transmission times.

The transmission times and maximum record sizes were calculated on a 1401 by CMC personnel using IBM's published formulas which are as follows:

I. Records Per Track

A. 1300 series devices Records/Track (R/T)

$$RT = \frac{MTC - HA2 - C_1}{(RA + C_2)}$$

MTC = Maximum Track Capacity

RT = Number of records / track

*C*₁ = Constant 1 for the device

*C*₂ = Constant 2 for the device

HA2 = Home Address 2 = minimum of 2 characters

RA = Record Address, minimum of 6 characters

Device		<i>MTC</i>	<i>C</i> ₁	<i>C</i> ₂
1301	6 bit mode	2840	2800	32
	8 bit mode	2205	2165	32
1302	6 bit mode	5902	5850	44
	8 bit mode	4585	4533	44

B. 2300 Series Devices—Records/Track (R/T)

$$R/T = \left[\frac{(c) - (b)}{(a)} \right] + 1 \text{ where}$$

(*a*) = bytes / record except last record on track

(*b*) = bytes / record last record on track only

(*c*) = capacity per track in bytes

KL = Key length in bytes

DL = Data length in bytes

C = Constant having values *C*₁ or *C*₂

where *C*₁ = Constant when *KL* ≠ 0

*C*₂ = Constant when *KL* = 0

Device	(<i>a</i>)	(<i>b</i>)	(<i>c</i>)	$\frac{C}{C_1 C_2}$
2301	186-C+(KL+DL)	53-C+(KL+DL)	20,483	0 53
2302	81-C+1.049(KL+DL)	20-C+(KL+DL)	4,984	0 20
2303	146-C+(KL+DL)	38-C+(KL+DL)	4,892	0 38
2311	81-C+1.049(KL+DL)	20-C+(KL+DL)	3,625	0 20
2314	101-C+ $\left[\frac{2137(KL+DL)}{2048} \right]$	C+(KL+DL)	7,294 45	0
2321	100-C+(KL+DL)	16-C+(KL+DL)	2,000	0 16

II. Transmission Times

Transmission times were calculated from the following published formula and are given in milliseconds

Trans Time = (bytes / record) x (data rate)

Data rates for the various devices are listed below:

Device	Data Rate in ms / byte or ms / character
1301	6-bit mode .011099
	8-bit mode .014265
1302	6-bit mode .005435
	8-bit mode .006993
1311	.020000
2301	.000833
2302	.006410
2303	.003200
2311	.006410
2314	.003205
2321	.018182



Supplement for Reference Table

for IBM Direct Access Mass Storage Units

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